

HEART

Editorial

Measurement of QT dispersion

In 1985, Mirvis¹ reported on a significant spatial variation in QT intervals in normal individuals and patients with acute myocardial infarction. More recently, there has been an increasing interest in what has become known as QT dispersion, which is defined as the difference between the maximum and minimum QT interval of the 12 lead ECG.² A number of publications has shown a relation between increased QT dispersion and death from a cardiac cause.³⁻⁵ Other studies have shown that QT dispersion can be reduced as a result of certain drug treatments.^{6,7} On the other hand, increased QT dispersion has been shown not to be associated with increased cardiac death in patients with idiopathic dilated cardiomyopathy.⁸ It has also been suggested that increased QT dispersion may be a marker of arrhythmia risk in patients with hypertrophic cardiomyopathy,⁹ long QT intervals,² and sustained ventricular arrhythmias.¹⁰

All of these studies have involved relatively small numbers of patients and, with the exception of one report,³ sensitivity and specificity of criteria have not been considered. Even in this study,³ the receiver operator characteristic (ROC) curve assessing different cut off values for abnormal QT dispersion was essentially developed on the basis of a training set.

A major question arises—is a single measurement of QT dispersion of any clinical utility despite the fact that trends in QT dispersion can be linked with adverse outcome or improvement?

To know whether a single measurement is reliable enough to have any prognostic value requires an understanding of the accuracy of measuring QT dispersion. In this connection, the articles by Kors and van Herpen¹¹ and Yi and colleagues¹² in this issue are of relevance. They provide an interesting sequel to earlier studies on QT dispersion assessed by manual or semiautomated methods,¹³ and a series of papers dealing with reliable detection of the end of the T wave,¹⁴⁻¹⁶ which is intimately related to measurement of QT dispersion.

Reproducibility

The paper by Yi *et al* presents data on repeated measurement of QT dispersion using a commercially available program.¹² It should be noted, however, that the sampling rate of this program is such that the interval between consecutive samples is 4 ms—that is, one sample error in measuring QT dispersion represents an error of 4 ms. It should also be noted that only 11 leads were used to measure QT dispersion as V1 was excluded on the basis that flat T waves are commonly encountered in this particular lead. It is arguable, however, that low T waves are more frequent in V1 than in lead III at least on the basis of our own normal data.¹⁷ However, other leads could be omitted from the calculation of QT dispersion essentially if their T wave amplitudes were low.

The tables in Yi *et al* have to be studied carefully—for example, they show that the mean (SD) relative error in global QT dispersion is 30.3 (26.6)% between recordings

in the supine position made 8 (3) days apart. The upper limit of relative error is therefore approximately 80%. Thus, a QT dispersion measurement of 32 ms on one occasion might well be 12 ms or 76 ms on a second repeat measurement given the definition of relative error used and the fact that measurements are made to the nearest 4 ms. Thus, any criterion aimed at measuring a significant change in QT dispersion will have to make allowance for repeat measurement error of this magnitude, although it could be speculated that higher relative errors will occur at smaller absolute values of QT dispersion. Note that for an approximate mean normal global QT dispersion of 20 ms, a repeat measurement with only one sample difference of ± 4 ms gives a relative of error of 18.2% or 22.2%.

Measurement error

The work of Kors and van Herpen¹¹ similarly emphasises measurement error but in this case these authors feel that measurement error itself is a significant source of QT dispersion on a single estimate. Indeed, they suggest that the error of measuring corrected QT dispersion from 12 leads is 31.5 (16.1) ms and for uncorrected QT dispersion, 29.4 (14.9) ms. What these authors are saying is that the actual error could be up to 60 ms. It should be noted that this is not the measurement of QT dispersion itself but the maximum error in measurement.

A measurement may well be repeatable but have the same amount of error on each occasion so that the two studies are assessing different aspects of measurement. Nevertheless, it is interesting to try to reconcile the two sets of results. Yi *et al* quote a mean normal global QT dispersion of 21.3 ms.¹² If the maximum relative error is taken to be 83.5% (mean +2 SD), then a repeated estimate of such a measurement could be 51.8 ms. The absolute difference is 30.5 ms, which is very similar to the mean measurement error of 29.4 ms obtained by Kors and van Herpen.¹¹ It is clearly much less than the maximum error of approximately 60 ms.

Kors and van Herpen point out that only two limb leads are required to measure variation in QT interval among all limb leads, given the relations that exist among them—for example, I + III = II. This means that if the lead with the shortest QT is excluded, the error in measuring QT intervals among the five remaining limb leads can be assessed. As these five leads theoretically should have the same T end and hence QT interval if a global QRS onset is used, any variation in QT intervals represents QT measurement error dispersion among five leads. Even here, however, the authors suggest that this could be approaching 50 ms maximum. While this error appears large, it represents a little over one small square on ECG paper recording at 25 mm/s.

Kors and van Herpen essentially extrapolated their method to 12 leads by using amplitude dependent errors from limb lead measurements of QT to represent errors in the measurement of precordial lead QT intervals. Whether this is valid is open to question—that is, using limb lead estimates to represent precordial lead error measurements.

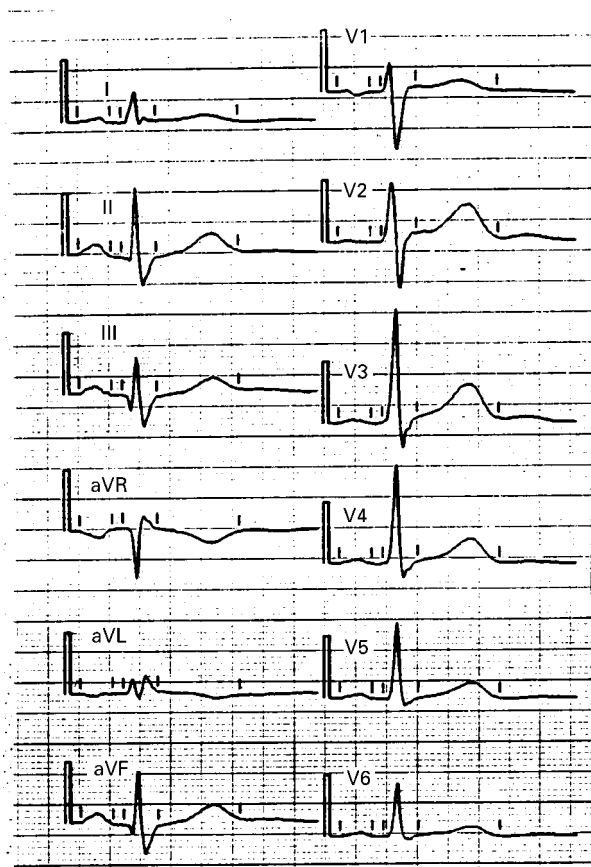


Figure 1 A 12 lead ECG analysed by computer with all leads recorded simultaneously. The tick marks for P and QRS onset and offset as well as T offset are at the same time instants in all 12 leads, displayed here at 50 mm/s. Note that V2 has the earliest QRS onset, which is almost 20 ms earlier than the first detectable QRS activity in most limb leads.

However, differences in QT dispersion measured in 12 leads compared to the use of five limb leads only are small, with the possibility of maximum measurement error being the order of 60 ms using 12 leads *v* 50 ms for five limb leads.

QRS onset and QT dispersion

Some further methodological observations can be made. First, Kors and van Herpen¹¹ and Yi and colleagues¹² who used commercial algorithms¹⁸ used a global QRS onset, whereas others, including those who have manually calculated QT dispersion by measuring QT intervals in individual leads, are inherently not using the same onset for all QRS complexes in different leads. Cowan *et al* showed some years ago that variation in QRS onset in a single 12 lead ECG could vary by up to 24 ms,¹⁹ so that this source of error is certainly not negligible. Indeed, Kors and van Herpen repeated part of their study using individual lead QRS onsets and found an increase in mean QT dispersion measurement error from 29.4 ms to 32.8 ms (an 11.6% increase in error).

The concept of an isoelectric or I segment at the onset of the QRS complex was recognised many years ago by the CSE study.²⁰ Figure 1 shows an example from our own dataset where I segments of approximately 20 ms can be seen in most limb leads with respect to the earliest QRS onset in V2. This suggests that there should be some agreement reached in how to measure QT dispersion.

Corrected QT interval and QT dispersion

Another point worth noting is that Kors and van Herpen¹¹ used both a corrected and an uncorrected QT interval for measuring QT dispersion, whereas Yi and colleagues¹²

used an uncorrected QT. Malik and Camm have recently pointed out²¹ that there is no justification for using a corrected QT interval for the derivation of QT dispersion, while it is clear that if a linear equation is used for QT dispersion (for example, that of Hodges and colleagues²²) there is no difference in QT dispersion measured from corrected or uncorrected intervals. Recently, Zabel and Wolfgang²³ provided experimental evidence to support the view that there is no need to correct QT dispersion for rate. Kors and van Herpen used the Bazett formula to correct QT dispersion, which, as they showed, results in differences between QT dispersion and QTc dispersion.

Conclusion

The clinical utility of QT dispersion continues to be assessed in many studies. The two papers in this issue^{11, 12} serve to point out that there is no standardisation in this measurement, as indeed there is not in many other measurements in computer based ECG analysis programs. Kors and van Herpen¹¹ conclude that it is only necessary to use six precordial leads plus two limb leads to measure QT dispersion on good theoretical grounds, whereas most other authors have used all 12 leads. Thus, the body of clinical data accumulated so far has been with the latter approach and it may not be helpful, no matter how theoretically correct, to switch to an alternative approach at this stage.

The data from Yi and colleagues¹² suggest that there is acceptable reproducibility of the measurement of QT dispersion at least in healthy subjects and point to the fact that there should be a reasonable time interval between what is regarded as the upper limit of normal QT dispersion and what could reliably be argued as an abnormal QT dispersion clearly allowing for measurement error. We have reported elsewhere that an upper limit of normal QT dispersion is 50 ms on the basis of a study of over 3000 neonates, infants, children, and adults.²⁴ The data of Yi *et al* from a relatively small number of adults confirm this as a highly specific value, while the data of Kors and van Herpen¹¹ would tend to suggest that a truly abnormal measurement of QT dispersion would appear to be one in excess of 80 ms. This is in keeping with a 50 ms QT dispersion having a relative measurement error of +46% and allows for a mean 29.4 ms error in 12 lead measurement of QT dispersion as indicated by Kors and van Herpen.¹¹ The figure of 80 ms as a clearly abnormal value of QTd fits with the summary data of Surawicz.²⁵ However, whether a threshold of 50 ms represents a moderately sensitive as well as specific criterion of abnormality remains worthy of consideration. From the data of Darbar *et al* it appears to have a sensitivity and specificity of 92% and 43%, respectively in predicting cardiac death in patients with peripheral vascular disease.⁴ A borderline value of 80 ms had a 67% sensitivity and 89% specificity in the same study.

Despite the foregoing reservations, increased QT dispersion has been linked in larger populations to an increased incidence of fatal and non-fatal myocardial infarction in the 6595 middle aged men in the West of Scotland Coronary Prevention Study,²⁶ and to an increased incidence of cardiac death in the 5812 patients in the Rotterdam study of the elderly.²⁷ The challenges, therefore, which remain, are to translate the findings from statistically large samples to a technique that is of value in the individual patient,^{25, 28} and to minimise the error in measurement of QT dispersion.

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STAMPS IN CARDIOLOGY

Blood transfusion

Stamps depicting different elements of blood transfusion have been issued relatively frequently to advertise and promote national blood donation campaigns and to raise funds for transfusion services. The Belgium blood transfusion stamp from 1959 was part of the set of six Red Cross stamps and shows blood dripping from the Red Cross emblem filling the stylised heart. The National

Blood Transfusion Service was the theme of the 20 paisa stamp issued by Pakistan in 1972, which also shows the emblem of the Red Cross. Japan issued a stamp featuring world blood donation in 1974 to commemorate International Red Cross Day. The stamp design incorporates the ABO blood groups, the world, and doves of peace.

